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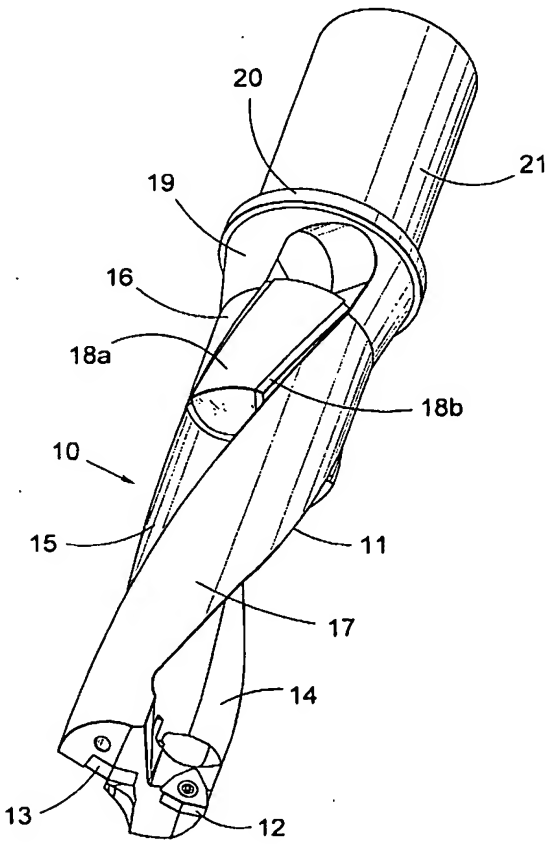
(54) Title: VIBRATION DAMPENED DRILLING TOOL



(57) Abstract: The invention relates to a drilling tool for hole-drilling in metallic materials, including a drill body (11) as well as at least one cutting insert (12) located in the front end thereof, defining the periphery of the drill, the drill body having a number of axially extending chip channels (14, 15) and bars (16, 17) situated therebetween. Characteristic of the new tool is that the drill body (11) has been provided with a damping unit (18) situated at an axial distance behind the cutting inserts in at least one chip channel which damping unit entirely or partly fills up a portion of said chip channel, and which damping unit is composed of two material portions (18a, 18b, 23a, 23b) made up of different rigidities.

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Vibration dampened drilling tool

The present invention relates to a drilling tool for working in metallic material, more precisely a drill of the type that comprises a drill body having at least one cutting insert which defines the periphery of the hole, the drill being formed with one or more recesses extending in the longitudinal direction of the drill which recesses join to the outer and inner inserts, respectively, in order to serve as grooves for chip release.

At working of holes in metallic materials, problems arise with the high sound level caused by vibrations from the working and the machine sound. Hitherto used drills have not been provided with built-in/added damping devices formed in such a way that a suitable sound and vibration damping has been feasible. The essential thing is to be able to eliminate major parts of the vibration sound in the range that is uncomfortable to the ear. If possible, only the machine sound as well as the inevitable chip rattle which normally usually amounts to 74-76 dB should be left. However, without damping it is not uncommon that levels up to 130 dB have been measured. The proper machine sound feels more restful to the ear.

By the Swedish patent 8902081-2, it is, for instance, previously known to form a drilling tool with a partly vibration damping material, which has been applied in the recess of the drill's chip channels formed in the longitudinal direction. However, the hard metal borders applied according to the patent 8902081-2 have not turned out to give any suitable silencing of noise.

In these circumstances, the aim of the invention is to provide a solution to the above-mentioned problem by forming a device for a drill which gives a substantially better sound and vibration damping effect, and which is useful at tapping as well as at the subsequent drilling. According to the invention, the drill is provided with recesses for chip release connecting to each cutting insert, in which recesses at least two composed damping elements having different rigidity are applied at an

axial distance behind the cutting inserts in such a way that they entirely or partly fill up an axial portion of said chip channel. In this way, the drill is given above all sound and vibration damping and also improved rigidity. As a result of this, the new tool permits a substantial reduction of the sound level that is caused by the proper metal working of the workpiece. At the same time, such a tool becomes less sensitive to vibrations, which arise by virtue of variations of the cutting forces.

Below, the invention will be described closer in connection with two embodiment examples of the invention illustrated in the drawings, where Fig. 1 shows a perspective view of an embodiment of the tool. Fig. 2 shows a perspective view of an alternative embodiment. Fig. 3 shows a cross-section through the collar portion along the line III-III of a drill according to Fig. 2. Figs. 4-11 show cross-sections of alternative embodiments of drills within the scope of the invention.

The embodiment of drill 10 having damping elements 18a and 18b according to the present invention illustrated in Fig. 1 comprises a drill body 11 as well as an outer cutting insert 12 situated at the periphery of the drill and an inner cutting insert 13 situated closer to the centre of the drill. The cutting inserts are preferably made of hard cemented carbide. The two cutting plates are situated in such a way at different radial distances from the drill axis A that their operating areas overlap each other. At the same time, said cutting plates are displaced about 180° in the periphery direction of the tool. The cutting plates 12 and 13 are, in a known way, for instance by means of screw joints, fastened in a corresponding cutting pocket in the drill body 11. The drill body 11 has a substantially cylindrical basic shape and is made out of steel.

At the portion of the drill body 11, situated behind the cutting inserts, the drill body is provided with axially extending, radially outwardly open recesses 14 and 15, which in cross-section are concavely bent and separately join to respective cutting plate 12 and 13. Said recesses 14, 15 are intended

to serve as chip channels and the bars 16 and 17 having a cylindrical envelope surface are situated therebetween. In the embodiment illustrated in Fig. 1, said chip channels 14, 15 are helical. Alternatively, the chip channels 14, 15 may have a straight design or a combination thereof. A distance axially behind the cutting plates 12, 13, damping elements have been placed in one or each one of the chip channels. The damping element 18 is composed from at least two parts 18a and 18b having substantially different rigidities. In the case illustrated here, the damping element 18a is applied with a shape adapted to the chip channel so that the top surface of the damping element 18a becomes situated flush with and with the same shape as the adjacent outer surface of the drill body 11. The damping element 18 has a shape that entirely or partly corresponds with the shape of the chip channel, while the outer envelope surface thereof may have a free design. The damping element 18a may, for instance, be fastened at the drill shank by means of a radially through screw joint. The damping element 18 should, in order to give the desired damping effect, be situated at an axial position a distance behind the cutting plates so that an undisturbed chip release is obtained at a predetermined bore depth. The drill body 11 is, at the axially rear portion thereof, in the common way formed with a rear sectional thickening in the shape of a conical portion 19 which transforms into a rear portion 20. In certain cases, the damping elements 18 can have such an axial extension that they also are extended through at least a part of said conical portion 19, this with the purpose of allowing a greater bore depth with the existing embodiment. The cylindrical part 21 situated axially behind the portion 20 is intended to be fixed in a machine spindle or holder part. It is not necessary that the shape of the element 18a entirely joins to the shape of the recess 15. The essential thing is that a satisfactory surface contact is secured between the side surfaces of the chip channel and the radially directed side surfaces of the damping element up to the transition to the envelope surface of the bars 16, 17.

In Figs. 2-3, an alternative embodiment is shown where the damping element is in the form of a cylindrical collar 22 with

a substantially larger outer diameter than the drill body 11 and two damping elements 23a and 23b which have been given such a shape that they along the length of the collar entirely or partly fill up the recesses 14, 15. The part 23b is brought inside the collar 22 entirely or partly in surface contact with the envelope surface of the bars, 16, 17 along substantially the entire length of the collar. The centre portion 23a and 22a, respectively, may be manufactured out of steel for instance, which is fastened at the inner wall of the collar by means of soldering, agglutination, welding or in another way.

Alternatively, the portion 18a, 23a can be manufactured out of a ceramic material, polymer, composite material or cemented carbide. The portion 18a, 23a surrounding the damping material 18b, 23b can be a material of the type elastomer, polymer, natural rubber or a glue and caulking compound. Also combinations of these materials are feasible.

The collar 22 is, at the embodiment illustrated in Figs. 2-3, composed of two collar halves 22a and 22b, which are held together around the drill body 10 by means of a screw joint. Alternatively, the collar can consist of more than 2 collar elements. As is seen in Fig. 2, each one of the collar halves are provided with circular recesses 24, in which a bottomed plane portion 25 forms a flange portion through which a hole 26 has been recessed for receipt of a bolt or screw (not shown) which extends therethrough and also through the opposite complementary formed flange portion of the opposite collar halves 22b thereof. The embodiment is such that a slot 27 remains between the two collar halves 22a, 22b. In the embodiment illustrated in Fig. 3, the damping element 23b has such a continuous extension that the same entirely fills up the two concavely formed chip recesses 14 and 15 as well as the same also entirely surrounds the envelope surface of the bars 16 and 17. Longitudinal channels in the drill body 10 for transportation of cooling liquid up to the bore tip are designated 28 and 29.

In Figs. 4-6, alternative embodiments of the damping elements are shown. In Fig. 4, the embodiment is such that the damping

material of a typically metallic or ceramic character 23a is entirely embedded and surrounded by the damping material 23b which has a typical rubber character or consists of another elastomer material. This material is intended to entirely fill up the respective chip recess 14, 15.

In the embodiment according to Fig. 5, a plurality of damping bodies 23a having varying cylindrical cross-section have been embedded in a material 23b of rubber or elastomer. Also in this case, the intention is that the accordingly composed damping unit should entirely fill up the respective chip recess 14, 15.

In the embodiment according to Fig. 6, the damping unit has received a sandwich embodiment, where the typically metallic or ceramic damping material 23a in the form of sheets alternately has been embedded between sheets of the damping material 23b having a typical rubber or elastomer character.

According to the alternative embodiment illustrated in Fig. 7, the typically metallic or ceramic damping material 23a has been given an embodiment being wedge-shaped in cross-section, the same on both sides being surrounded by the material 23b having a typical rubber or elastomer character. In this case, it is not required that the two damping materials in their entirety fill up the respective chip recess 14, 15.

According to Fig. 8, the harder material 23a has been fitted into the recess 15 as a U-shaped segment, which only partly fills up the recess 15, the more elastic damping material 23b also in the form of an inserted U-shaped segment, being fitted in between the material 23a and the bottom surface of the recess 15.

According to the alternative embodiment illustrated in Fig. 9, the typically metallic or ceramic damping material 23a has entirely been enclosed by a damping material 23b of rubber or elastomer character so that the shape of the composed damping units have become triangular. With such an embodiment, it is not required that the two damping materials entirely should

fill up the respective chip recess in order to attain a suitable silencing of noise.

According to an additional alternative embodiment, the damping element consists of the collar 22 together with the more elastic damping material 18b, 23b. Such an embodiment is closer illustrated in Fig. 10. As is seen therein, it is sufficient to let the damping material 18b, 23b be extended only along the envelope surfaces of the two bars 16, 17. In such a case, also the slots 27 may have another position than what previously has been shown in Fig. 3. As a suitable material in the collar 22, material of the same type that previously has been indicated for the element 18a, 23a may then be chosen.

According to an alternative embodiment shown in Fig. 11, the collar 22 is composed of two collar halves 22a and 22b having an axial slot 27 therebetween, but in this the case there is no direct surface contact between the collar and the drill body 11, since the inner diameter of the collar is larger than the outer diameter of the drill body 11 so that a ring-shaped gap 30 is formed therebetween. According to this embodiment, the material portions 23a, which consist of metal, ceramics or polymer material, have been fastened at the inner surface of the collar and they have been formed so that they entirely fill up the recesses 14 and 15. Alternatively, the embodiment can be such that said portions 23a only partly fill up the recesses 14 and 15. In view of the illustrated embodiment, the inner envelope surface of the element 23a has been given a convex shape adapted to the shape of the recess 14 while the outer envelope surface thereof has been given a convex shape with a considerably larger bending radius adapted to the inner diameter of the collar half 22. At the same time, the softer and more elastic damping material 23b have been formed as a shim U-shaped in cross-section, which has been fitted in between the element 23a and the 14 bottom of the recess. The corresponding insert of a harder and a softer damping material has been applied in the diametrically opposite recess 15 in the drill body, as has been shown in Fig. 11.

Claims

1. Drilling tool for hole-drilling in metallic materials, including a drill body (11) as well as at least one cutting insert (12) located in the front end thereof defining the periphery of the drill, the drill body having a number of axially extending chip channels (14, 15) and bars (16, 17) situated therebetween, c h a r a c t e r i z e d in that the drill body (11) has been provided with a first damping element (18) situated at an axial distance behind the cutting inserts of the drill body and a second damping elements situated in a gap radially inside said first damping element, said damping elements being composed of two material portions (18a, 18b, 23a, 23b) made up of different rigidities.

2. Drilling tool according to claim 1, c h a r a c t e r i z e d in that the first damping element (18) is partly received in said chip channel (14, 15).

3. Drilling tool according to claim 1 or 2, c h a r a c t e r i z e d in that the chip channels cross-section-wise are concavely bent, the damping element (18) consisting of an unsymmetrical cylinder rod, the inner envelope surface of which has a cylindrical shape corresponding with the bending radius of the chip channel while the outer envelope surface of the damping element (18) has a larger radius substantially corresponding with the bending radius being defined by the outer envelope surface of the bars (16, 17).

4. Drilling tool according to claim 1, 2 or 3, c h a r a c t e r i z e d in that the damping element (18) is situated so that it joins directly to the radially formed collar portion (19, 20), which separates the front drill portion from the rear cylinder surface (21), which should be fastened in an appurtenant machine spindle for rotational driving in an appurtenant machine.

5. Drilling tool according to any one of claims 1-4, c h a r a c t e r i z e d in that the damping element (18) has

been given the form of a partly cylindrical insert fastened on the inside of the damping element formed as a collar (22) having a substantially larger diameter than the diameter of the drill, the centre portion of the collar being formed with a hole diameter corresponding with the one of the bars and at the same time via the portion (23b) of the damping element being in frictional engagement with the entire envelope surface of the bars (16, 17) along the entire length of the collar (22).

6. Drilling tool according to claim 5, c h a r a c t e r i z e d in that the collar (22) is composed of at least 2 collar parts having axially directed slots (27) therebetween.

7. Drilling tool according to any one of claims 1-6, c h a r a c t e r i z e d in that the damping element comprises a portion (18a, 23a) consisting of a metal, polymer, ceramic material, composite or cemented carbide, which has a partly cylindrical, triangular or another cross-section-shape, and that the same is at least partly surrounded by a material portion (18b, 23b) of rubber, polymer or elastomer character, which is entirely or partly adjusted to the shape of the first portion (18a, 23a).

8. Drilling tool according to any one of claims 1-7, c h a r a c t e r i z e d in that the relatively seen softer damping element (23b) has such a continuous extension that the same entirely fills up the two concavely shaped chip recesses (14, 15) in the drill body and furthermore entirely surrounds the envelope surface of the bars (16, 17) therebetween.

9. Drilling tool according to any one of claims 1-8, c h a r a c t e r i z e d in that the damping element comprises a portion of rubber, polymer or elastomer material entirely filling up the chip recesses (14, 15), and that a cylindrical portion (23a) of the relatively seen harder damping material has the shape of a border having a cylindrical cross-section entirely contained in the first relatively seen softer damping material (23b).

10. Drilling tool according to claim 9, c h a r a c t e r i z e d in that a plurality of mutually spaced-apart cylindrical portions (23a) of various size are embedded in the relatively seen softer damping material (23b).

11. Drilling tool according to any one of claims 1-7, c h a r a c t e r i z e d in that the damping element is of a sandwich embodiment, where at least one metallic, ceramic or polymer material is alternately embedded as sheets between sheet-shaped segments made out of the relatively seen softer material of rubber, polymer or elastomer character.

12. Drilling tool according to claim 1, c h a r a c t e r i z e d in that the harder damping material (23a) is fitted in as a segment, being U-shaped in cross-section, to one of the recesses (14, 15) of the drill and partly fills up the same, and that the more elastic damping material (23b) is fitted in as a likewise in cross-section U-shaped segment, forming an intermediate layer between the aforementioned material (23a) and the wall surface of the recess (15).

13. Drilling tool according to claim 1, c h a r a c t e r i z e d in that damping unit comprises a collar composed of two or more collar halves (22a, 22b) arranged on the drill body and partly axially surrounding the same, the inner diameter of which halves is larger than the outer diameter of the drill body (11) so that a ring gap (30) is formed therebetween, and that the material portions (23a) consisting of metal, ceramic or polymer material are fastened at the interior of the collar halves and formed in such a way that they entirely or partly fill up the recesses (14, 15), a damping material being softer and more elastic relatively the material (23a) has been applied as a shim (23b), being U-shaped in cross-section, between the material (23a) and the concavely bent surface of the recesses (14, 15).

Fig. 1

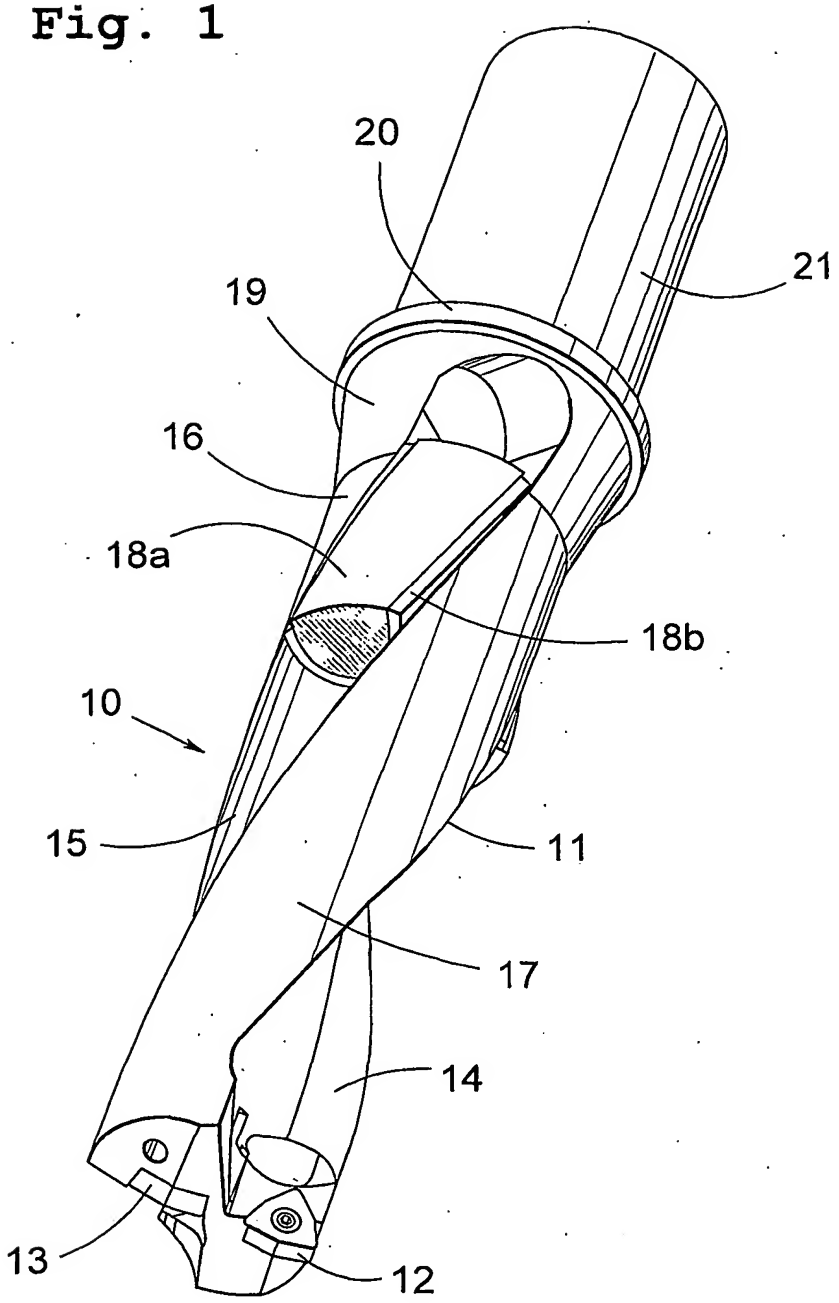


Fig. 2

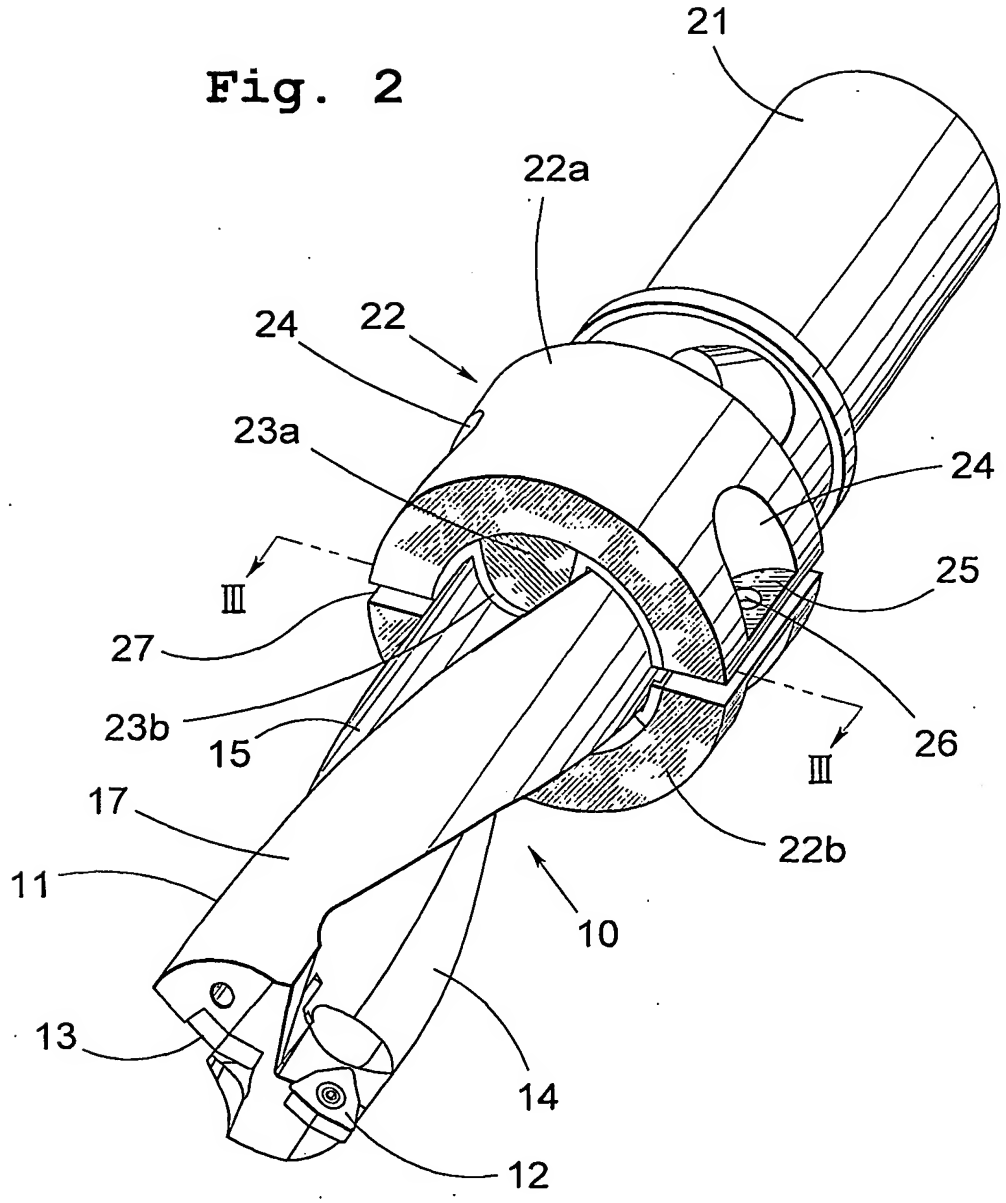


Fig. 3

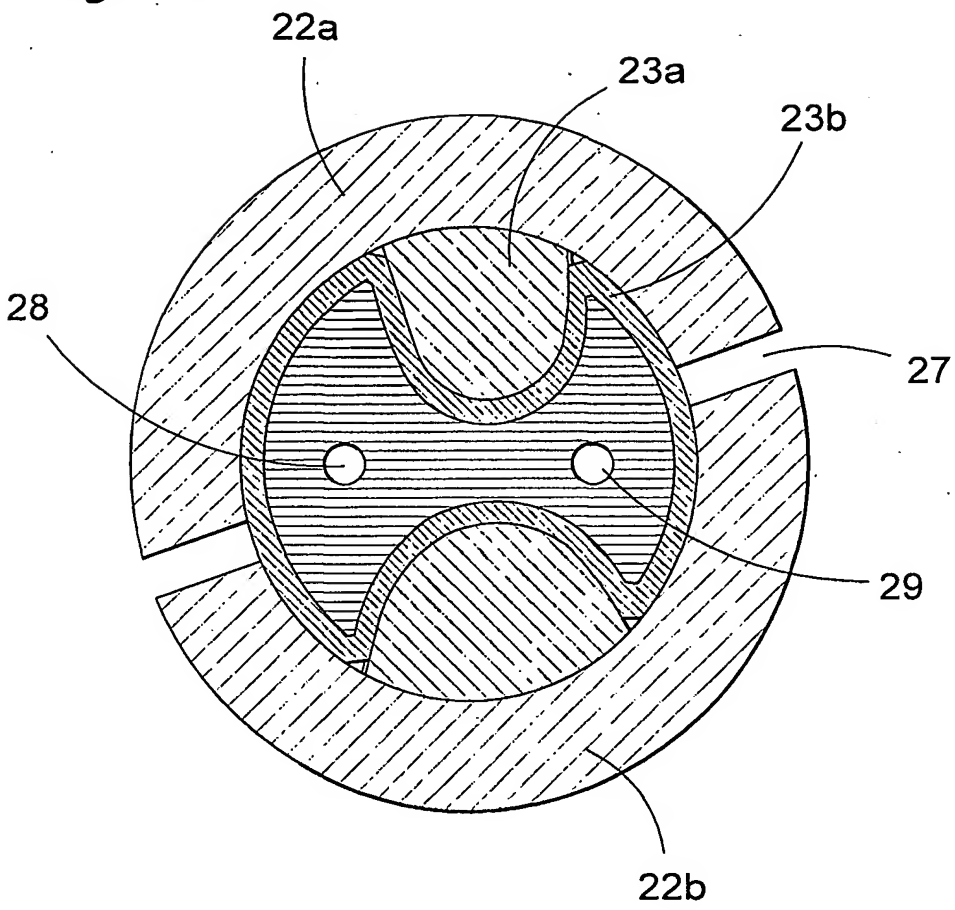


Fig. 4

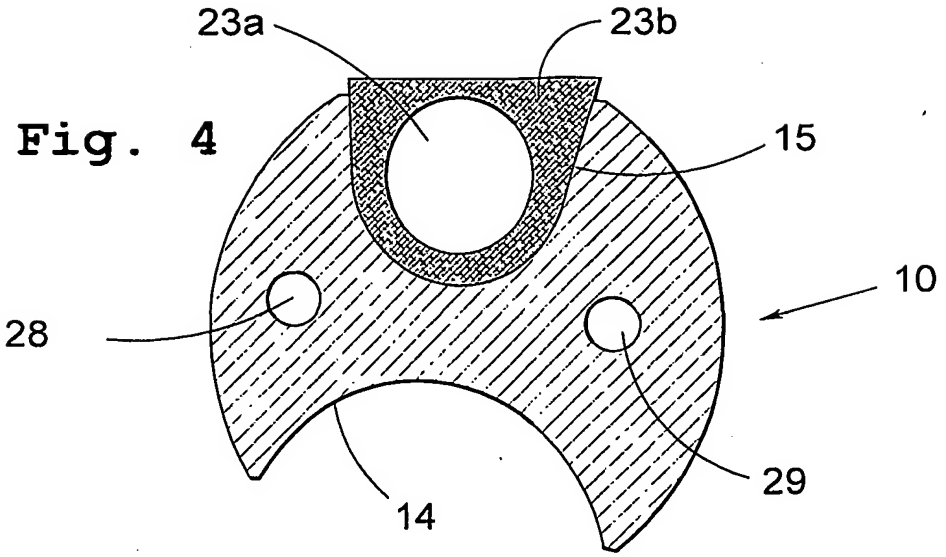


Fig.5

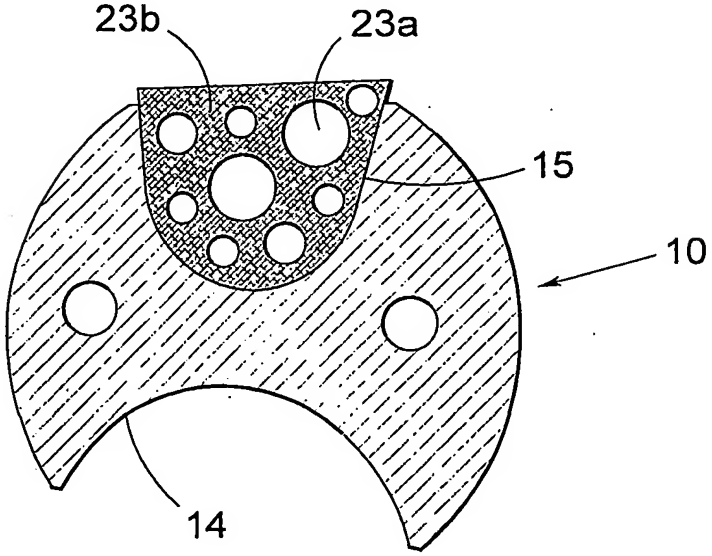


Fig. 6

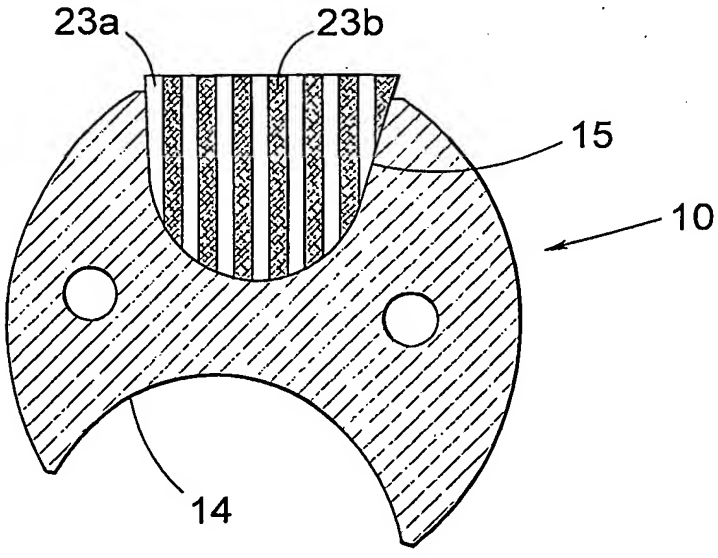


Fig. 7

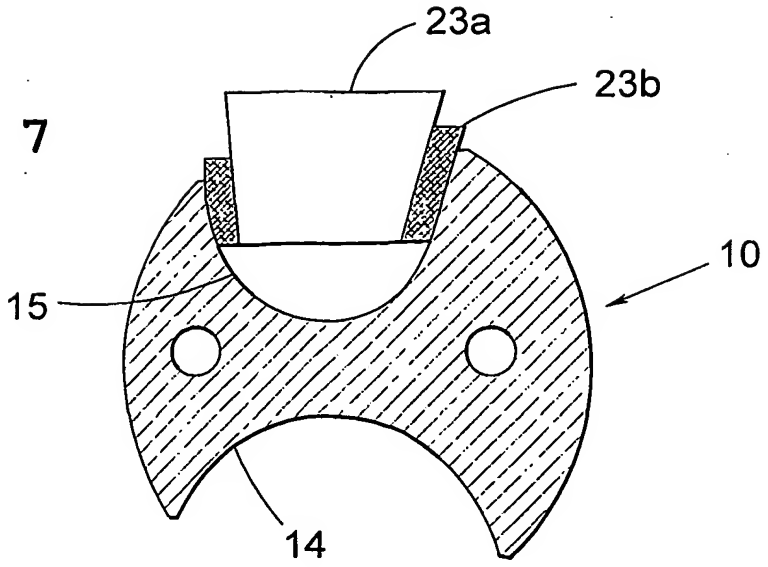


Fig. 8

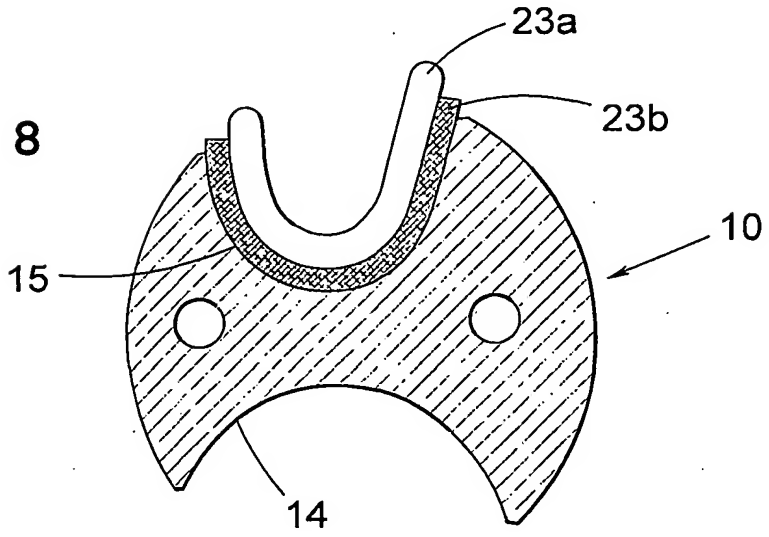


Fig. 9

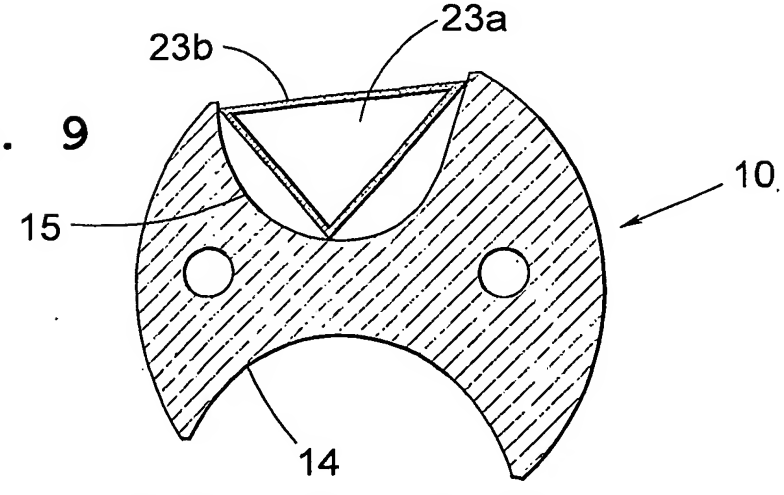


Fig. 10

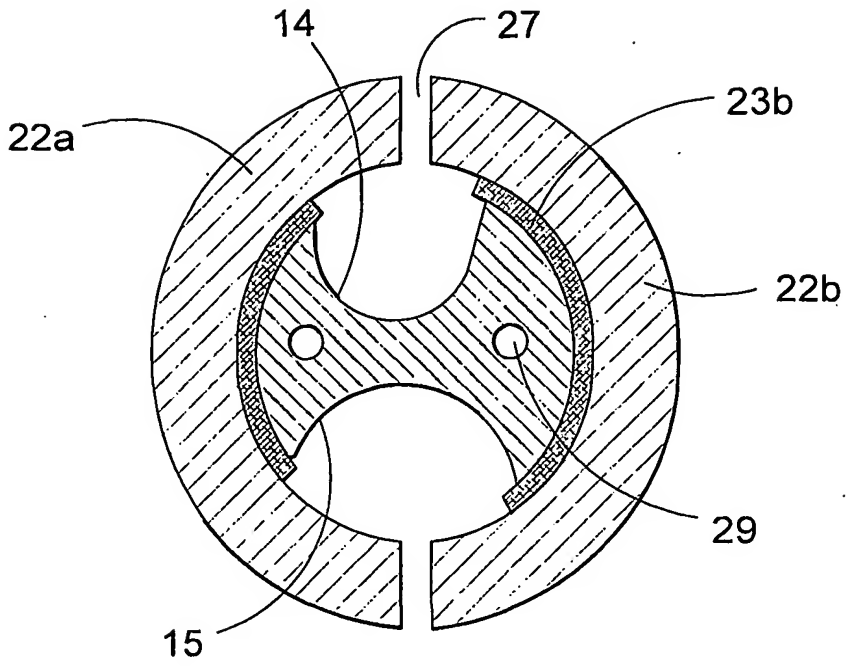
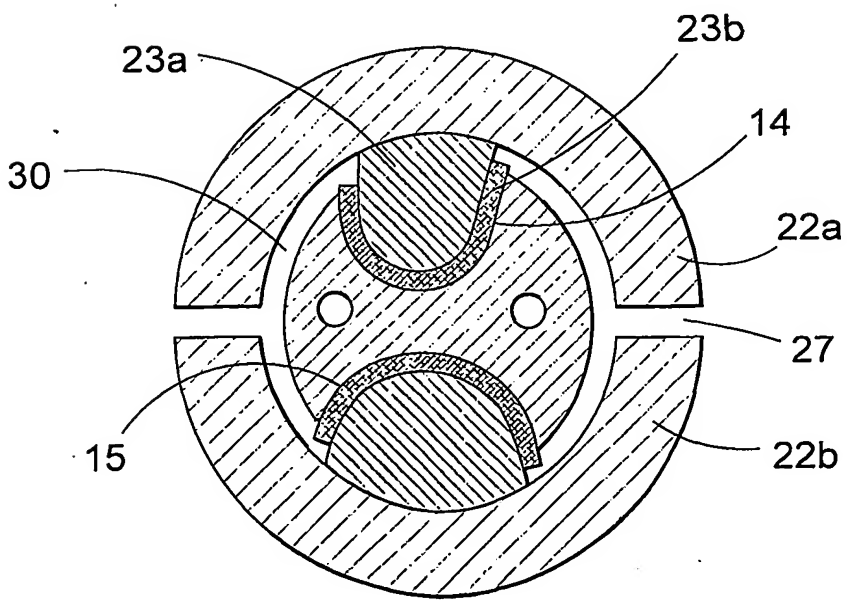


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/01247

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B23B 51/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23B, B23Q, E21B, E21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI-DATA, EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WPI/Derwent's abstract, Accession Number 1991-041795, week199106, ABSTRACT OF SE, 8902081 A (SANDVIK AB), 10 December 1990 (10.12.1990). --	1-13
A	US 4393947 A (UWE LUTZE ET AL), 19 July 1983 (19.07.83), column 1, line 25 - line 30; column 1, line 39 - line 42, figure 1, abstract --	1-13

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
3 Sept 2001	26 -09- 2001
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Form PCT/ISA/210 (second sheet) (July 1998)

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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